Claims

1. 1. A polylactic acid resin comprising a linear polylactic acid with a relative viscosity ηrel of in the range of 2.7 to 3.9, prepared from lactic acid monomers wherein at least 95 mol% of the lactic acid is an L-isomer, and wherein the resin contains 0 to 30 ppm of tin (Sn) and 0 to 0.5% by weight of residual monomer.

2. A polylactic acid resin comprising a linear polylactic acid with a weight average molecular weight Mw in the range of 120,000 to 220,000, and a number average molecular weight Mn in the range of 60,000 to 110,000 prepared from lactic acid monomers wherein at least 95 mol% of the lactic acid is an L-isomer, and wherein the resin contains 0 to 30 ppm of Sn and 0 to 0.5% by weight of residual monomer.

3. A polylactic acid fiber comprising the polylactic acid resin according to claim 1.

4. A process for producing a polylactic acid fiber by melt-spinning the polylactic acid according to claim 1.

5. A multifilament comprising a linear polylactic acid with a relative viscosity ηrel of in the range of 2.7 to 3.9, prepared from lactic acid monomers wherein at least 98 mol% of the lactic acid is an L-isomer, and wherein the resin contains 0 to 30 ppm of Sn and 0 to 0.5% by weight of residual monomer.

6. A multifilament comprising a linear polylactic acid with a weight average molecular weight Mw in the range of 120,000 to 220,000 and a number average molecular weight Mn in the range of 60,000 to 110,000, prepared from lactic acid monomers wherein at least 98 mol% of the lactic acid is an L-isomer, and wherein the resin contains 0 to 30 ppm of Sn and 0 to 0.5% by weight of residual monomer.

7. A multifilament according to claim 5 having a tensile strength of 3.9 cN/dtex or more, a contraction ratio in boiling water of 12% or less, a birefringence, Δn, of 0.030 or more, and a thermal stress peak temperature of 85°C or more.

8. A polylactic acid multifilament according to claim 5 having an inert content of 3.0% or less and a contraction ratio in boiling water of 12% or less.

9. A process for producing a polylactic acid multifilament using a polylactic acid comprising a linear polylactic acid with a relative viscosity ηrel of in the range of 2.7 to 3.9, prepared from lactic acid monomers wherein at least 98 mol% of the lactic acid is an L-isomer, and wherein the resin contains 0 to 30 ppm of Sn and 0 to 0.5% by weight of residual monomer wherein the process steps comprise: spinning the resin at a speed in the range of 3,000 m/min to 5,000 m/min; drawing at a draw magnification factor 1.3 times or more at a temperature in the range of 100°C to 125°C; and heat-setting at a temperature in the range of 125°C to 150°C.

10. A process for producing a polylactic acid using a polylactic acid comprising a linear polylactic acid with a weight average molecular weight Mw in the range of 120,000 to 220,000 and a number average molecular weight Mn in the range of 60,000 to 110,000, prepared from lactic acid monomers wherein at least 98 mol% of the lactic acid is an L-isomer, and wherein the resin contains 0 to 30 ppm of Sn and 0 to 0.5% by weight of monomer wherein the process steps comprise: spinning the resin at a speed in the range of 3,000 m/min to 5,000 m/min; drawing at a draw magnification factor of 1.3 times or more at a temperature in the range of 100°C to 125°C; and heat-setting at a temperature in the range of 125°C to 150°C.

11. A process for producing polylactic acid multifilament using the polylactic acid resin according to claim 5 wherein drawing is between a first heated roller (1) and a second heated roller (2) followed by heat-setting with the second heated roller (2).

12. A polylactic acid staple fiber comprising the polylactic acid resin according to Claim 1 or 2.

13. A polylactic acid staple fiber according to claim 12 having a tensile strength of 2.6 cN/dtex or more, an elongation of 80% or less, a contraction ratio in boiling water of 5.0% or less and a crimp number in the range of 4 to 18 crimps/25 mm.

14. A process for producing a polylactic acid staple fiber using the polylactic acid resin comprising a linear polylactic acid with a relative viscosity ηrel of in the range of 2.7 to 3.9, prepared from lactic acid monomers wherein at least 95 mol% of the lactic acid is an L-isomer, and wherein the resin contains 0 to 30 ppm of Sn and 0 to 0.5% by weight of residual monomer wherein the process steps comprise: spinning at a speed in the range of 600 to 1,200 m/min; drawing by a draw magnification factor in the range of 3.0 to 5.0 times; and heat-treating at a temperature in the range of 110°C to 150°C.

15. A process for producing a polylactic acid staple fiber using the polylactic acid resin comprising a linear polylactic acid with a weight average molecular weight Mw in the range of 120,000 to 220,000 and a number average molecular weight Mn in the range of 60,000 to 110,000, prepared from lactic acid monomers wherein at least 95 mol% of the lactic acid is an L-isomer, and wherein the resin contains 0 to 30 ppm of Sn and 0 to 0.5% by weight of monomer wherein the process steps comprise: spinning at a speed in the range of 600 to 1,200 m/min;

drawing by a magnification factor in the range of 3.0 to 5.0 times; and heat-treating at 110°C to 150°C.

16. A polylactic acid monofilament comprising a linear polylactic acid with a relative viscosity ηrel of in the range of 2.7 to 4.5, prepared from lactic acid monomers wherein at least 95 mol% of the lactic acid is an L-isomer, and wherein the resin contains 0 to 30 ppm of Sn and 0 to 0.5% by weight of residual monomer.

17. A polylactic acid monofilament comprising a linear polylactic acid with a weight average molecular weight Mw in the range of 120,000 to 220,000 and a number average molecular weight Mn in the range of 60,000 to 110,000, prepared from lactic acid monomers wherein at least 95 mol% of the lactic acid is an L-isomer, and wherein the resin contains 0 to 30 ppm of Sn and 0 to 0.5% by weight of residual monomer.

18. A polylactic acid monofilament according to Claim 16 having a tensile strength of 3.5 cN/dtex or more, an elongation of 40.0% or less, a contraction ratio in boiling water of 10.0% or less and a birefringence, Δn, of 0.0250 or more.

19. A process for producing a polylactic acid monofilament using a polylactic acid resin comprising a relative viscosity ηrel of in the range of 2.7 to 4.5, prepared from lactic acid monomers wherein at least 95 mol% of the lactic acid is an L-isomer, and wherein the resin contains 0 to 30 ppm of Sn and 0 to 0.5% by weight of residual monomer wherein the process steps comprise: spinning at a temperature in the range of 220°C to 250°C, drawing at a draw magnification factor of 6.0 or more at a temperature in the range of 70°C to 100°C, and heat-treating at a temperature in the range of 100°C to 150°C.

20. A process for producing polylactic acid monofilament using a polylactic acid resin comprising a weight average molecular weight Mw in the range of 120,000 to 220,000 and a number average molecular weight Mn in the range of 60,000 to 110,000, prepared from lactic acid monomoers wherein at least 95 mol% of the lactic acid is an L-isomer, and wherein the resin contains 0 to 30 ppm of Sn and 0 to 0.5% by weight of residual monomer wherein the process steps comprise: spinning at a temperature in the range of 220°C to 250°C, drawing at a draw magnification factor of 6.0 or more at a temperature in the range of 70°C to 100°C, and heat-treating at a temperature in the range of 100°C to 150°C.

21. A flat yarn comprising a liner polylactic acid resin prepared from lactic acid monomers wherein at least 95 mol% of the lactic acid is an L-isomer.

22. A flat yarn according to claim 21, wherein the polylactic acid resin contains 0 to 0.5% by weight of lactic acid monomers.

23. A flat yarn according to claim 21, wherein the polylactic acid resin contains 0 to 30 ppm of Sn.

24. A flat yarn according to claim 21, wherein the polylactic acid resin has a relative viscosity in the range of 2.7 to 4.5.

25. A flat yarn according to claim 23, wherein the polylactic acid resin has a relative viscosity in the range of 2.7 to 4.5.

26. A flat yarn according to claim 21, wherein the polylactic acid resin has a Mw in the range of 125,000 to 230,000 and a Mn in the range of 73,000 to 116,000.

27. A flat yarn according to claim 23, wherein the polylactic acid resin has a Mw in the range of 125,000 to 230,000 and a Mn in the range of 73,000 to 116,000.

28. A flat yarn according to claim 21, wherein the polylactic acid resin has a Mw in the range of 125,000 to 230,000 and a Mn in the range of 73,000 to 116,000

29. A flat yarn according to claim 24 having a tensile strength of 2.6 cN/dtex or more, an elongation of 40.0% or less, and a contraction ratio in hot air at 80°C for 10 minutes of 5.0% or less.

30. A flat yarn according to claim 25 having a tensile strength of 2.6 cN/dtex or more, an elongation of 40.0% or less, and a contraction ratio in hot air at 80°C for 10 minutes of 5.0% or less.

31. A flat yarn according to claim 26 having a tensile strength of 2.6 cN/dtex or more, an elongation of 40.0% or less, and a contraction ratio in hot air at 80°C for 10 minutes of 5.0% or less.

32. A flat yarn according to claim 27 having a tensile strength of 2.6 cN/dtex or more, an elongation of 40.0% or less, and a contraction ratio in hot air at 80°C for 10 minutes of 5.0% or less.

33. A process for producing a flat yarn from a polylactic acid resin according to any one of claims 21 or 22.

34. A process for producing a flat yarn from a polylactic acid resin according to claim 23.

35. A process for producing a flat yarn from a polylactic acid resin according to claim 24.

36. A process for producing a flat yarn from a polylactic acid resin according to claim 25.

37. A process for producing a flat yarn from a polylactic acid resin according to claim 26.

38. A process for producing a flat yarn from a polylactic acid resin according to claim 27.

39. A process for producing a polylactic acid flat yarn comprising the steps: melt-extruding a polylactic acid resin according to claim 21 or 22 to form a film, followed by drawing at a drawing temperature of 80°C to 130°C with a draw magnification factor of 4.0 or more.

40. A process for producing a polylactic acid flat yarn comprising the steps: melt-extruding a polylactic acid resin according to claim 23 to form a film, followed by drawing at a drawing temperature of 80°C to 130°C with a draw magnification factor of 4.0 or more.

41. A process for producing a polylactic acid flat yarn comprising the steps: melt-extruding a polylactic acid resin according to claim 24 to form a film, followed by drawing at a drawing temperature of 80°C to 130°C with a draw magnification factor of 4.0 or more.

42. A process for producing a polylactic acid flat yarn comprising the steps: melt-extruding a polylactic acid resin according to claim 25 to form a film, followed by drawing at a drawing temperature of 80°C to 130°C with a draw magnification factor of 4.0 or more.

43. A process for producing a polylactic acid flat yarn comprising the steps: melt-extruding a polylactic acid resin according to claim 26 to form a film, followed by drawing at a drawing temperature of 80°C to 130°C with a draw magnification factor of 4.0 or more.

44. A process for producing a polylactic acid flat yarn comprising the steps: melt-extruding a polylactic acid resin according to claim 27 to form a film, followed by drawing at a drawing temperature of 80°C to 130°C with a draw magnification factor of 4.0 or more.

45. A polylactic acid false-twist yarn comprising a polylactic acid resin prepared from lactic acid monomers wherein the monomer content in the polylactic acid is 0 to 0.5% by weight.

46. A polylactic acid false-twist yarn according to claim 45 wherein the polylactic acid is prepared from lactic acid monomers and at least 95 mol% of the lactic acid is an L-isomer.

47. A polylactic acid false-twist yarn according to claim 45 wherein the polylactic acid resin is linear in structure.

48. A polylactic acid false-twist yarn according to claim 45 wherein the polylactic acid resin has an ηrel in the range of 2.7 to 3.9.

49. A polylactic acid false-twist yarn according to claim 47, wherein the polylactic acid resin has ηrel in the range of 2.7 to 3.9.

50. A polylactic acid false-twist yarn according to claim 45, wherein the polylactic acid contains 0 to 30 ppm of Sn.

51. A polylactic acid false-twist yarn according to claim 47, wherein the polylactic acid contains 0 to 30 ppm of Sn.

52. A polylactic acid false-twist yarn according to claim 48, wherein the polylactic acid contains 0 to 30 ppm of Sn.

53. A polylactic acid false-twist yarn according to claim 49, wherein the polylactic acid contains 0 to 30 ppm of Sn.

54. A polylactic acid false-twist yarn according to claim 45 having a tensile strength of 2.4 cN/dtex or more.

55. A polylactic acid false-twist yarn according to claim 47 having a tensile strength of 2.4 cN/dtex or more.

56. A polylactic acid false-twist yarn according to claim 48 having a tensile strength of 2.4 cN/dtex or more.

57. A polylactic acid false-twist yarn according to claim 49 having a tensile strength of 2.4 cN/dtex or more.

58. A polylactic acid false-twist yarn according to claim 45 having an expansion/contraction recovery ratio of 10% or more.

59. A polylactic acid false-twist yarn according to claim 50 having an expansion/contraction recovery ratio of 10% or more.

60. A polylactic acid false-twist yarn according to claim 51 having an expansion/contraction recovery ratio of 10% or more.

61. A polylactic acid false-twist yarn according to claim 52 having an expansion/contraction recovery ratio of 10% or more.

62. A process for producing a polylactic acid false-twist yarn from an non-drawn polylactic acid yarn wherein the polylactic acid resin is according to claim 45 having Δn of 0.010 to 0.035, a tensile strength S cN/dtex and ultimate elongation percentage E represented by the relation of $15 \leq S \times \sqrt{E} \leq 23$, wherein the process comprises the steps: subjecting the non-drawn polylactic acid yarn to a simultaneous draw and false-twist processing at a draw temperature of 110°C or more and a draw magnification factor in the range of 1.3 to 1.8.

63. A process for producing a polylactic acid false-twist yarn from an non-drawn polylactic acid yarn wherein the polylactic acid resin is according to claim 47 having Δn of 0.010 to 0.035, a tensile strength S cN/dtex and ultimate elongation percentage E represented by the relation of $15 \leq S \times \sqrt{E} \leq 23$, wherein the process comprises the steps subjecting the non-drawn polylactic acid yarn to a simultaneous draw and false-twist processing at a draw temperature of 110°C or more and a draw magnification factor in the range of 1.3 to 1.8.

64. A process for producing a polylactic acid false-twist yarn from an non-drawn polylactic acid yarn wherein the polylactic acid resin is according to claim 48 having Δn of 0.010 to 0.035, a tensile strength S cN/dtex and ultimate elongation percentage E represented by the relation of $15 \leq S \times \sqrt{E} \leq 23$, wherein the process comprises the steps subjecting the non-drawn polylactic acid yarn to a simultaneous draw and false-twist processing at a draw temperature of 110°C or more and a draw magnification factor in the range of 1.3 to 1.8.

65. A process for producing a polylactic acid false-twist yarn from an non-drawn polylactic acid yarn wherein the polylactic acid resin is according to claim 49 having Δn of 0.010 to 0.035, a tensile strength S cN/dtex and ultimate elongation percentage E represented by the relation of $15 \leq S \times \sqrt{E} \leq 23$, wherein the process comprises the steps subjecting the non-drawn polylactic acid yarn to a simultaneous draw and false-twist processing at a draw temperature of 110°C or more and a draw magnification factor in the range of 1.3 to 1.8.

66. A binder fiber comprising a polylactic acid resin comprising a linear polylactic acid with a relative viscosity ηrel of in the range of 2.7 to 3.9, prepared from lactic acid monomers wherein at least 90 mol% of the

lactic acid is an L-isomer, and wherein the resin contains 0 to 30 ppm of Sn and 0 to 0.5% by weight of residual monomer.

67. A binder fiber comprising a polylactic acid resin comprising a linear polylactic acid with a weight average molecular weight Mw in the range of 120,000 to 220,000 and a number average molecular weight Mn in the range of 60,000 to 110,000, prepared from lactic acid monomers wherein at least 90 mol% of the lactic acid is an L-isomer, and wherein the resin contains 0 to 30 ppm of Sn and 0 to 0.5% by weight of residual monomer.

68. The binder fiber according to claim 66 having a structure with a core and a sheath , wherein the core contains a polylactic acid resin wherein at least 98 mol% of the lactic acid is an L-isomer, and the sheath contains a polylactic acid resin wherein at least 90 mol% of the lactic acid is an L-isomer.

69. The binder fiber according to claim 68 having a structure with a core and a sheath , wherein the proportion C (mol%) of L-isomer in polylacitc acid of the core and the proportion S (mol%) of L-isomer in the polylactic acid of the sheath satisfies the relation: $2 \leq C - S \leq 8$.

70. The binder fiber according to claim 68 having a tensile strength of 2.6 cN/dtex or more, an elongation of 80% or less, a heat-contraction ratio at 80°C of 15.0% or less, and a crimp number in the range of 4 to 18 crimps/25 mm.

71. A process for producing a polylactic acid binder fiber according to claim 66 comprising the steps: spinning at a spinning temperature in the range of 210°C to 240°C and spinning speed in the range of 600 to 1,200 m/min, drawing at a draw magnification factor in the range of 3.0 to 5.0 at a draw temperature in the range of 40°C to 70°C, and heat-treating at a temperature in the range of 60°C to 90°C.

72. A filament nonwoven fabric comprising polylactic acid binding fibers having a structure with a core and a sheath, wherein the core-to-sheath ratio is in the range of 1 : 1 to 5 : 1 in area, and wherein the sheath comprises a polylactic acid having a lower melting point than the core, the sheath comprises a blend of polylactic acid and a second biodegradable polymers having a lower melting point than polylactic acid.

73. A filament nonwoven fabric comprising polylactic acid binder fiber having a structure with a core and a sheath, wherein (a) the core comprises a linear polylactic acid with a relative viscosity ηrel of in the range of 2.5 to 3.5, prepared from lactic acid monomers wherein at least 98 mol% of the lactic acid is an L-isomer, and wherein the resin contains 0 to 30 ppm of Sn and (b) the sheath comprises a linear polylactic acid with a relative viscosity ηrel of in the range of 2.5 to 3.5, prepared from lactic acid monomers wherein at least 96 mol% of the lactic acid is an L-isomer, and wherein the resin contains 0 to 30 ppm of Sn, the core-to-sheath ratio being 1 : 1 to 5 : 1 in area.

74. A filament nonwoven fabric comprising polylactic acid wherein the filament has a structure with a core and a sheath , wherein (a) the core comprises a linear polylactic acid with a relative viscosity ηrel of in the range of 2.5 to 3.5 prepared from lactic acid monomers wherein at least 98 mol% of the lactic acid is an L-isomer, and wherein the resin contains 0 to 30 ppm of Sn and (b) the sheath comprises a blend of a linear polylactic acid with a relative viscosity ηrel of in the range of 2.5 to 3.5, prepared from lactic acid monomers wherein at least 98 mol% of the lactic acid is an L-isomer, and wherein the resin contains 0 to 30 ppm of Sn and a polybutylene succinate synthesized from 1,4-butanediol and succinic acid with urethane bonds, the blend containing

50% to 90% by weight of the polylactic acid and the core to sheath ratio being 1 : 1 to 5 : 1 in area.

75. A filament nonwoven fabric of polylactic acid according to claim 72 having a mean fineness of 1 to 15 dtex, a mass per unit area of 10 to 200 g/m^2 and a longitudinal tensile strength of 30N or more.